(12) UK Patent Application (19) GB (11) 2 311 643 (13) A

(43) Date of A Publication 01.10.1997

(21) Application No 9705790.5

(22) Date of Filing 20.03.1997

(30) Priority Data
(31) 96007561 (32) 20.03.1996 (33) KR

(51) INT CL[6]
G02F 1/1335 , G09G 3/34

(52) UK CL (Edition O)
G5C CA342 CHX

(56) Documents Cited
GB 2291734 A WO 94/09474 A

(58) Field of Search
UK CL (Edition O) G5C CHX
INT CL[6] G02F 1/1335 , G09G 3/34
ONLINE: EDOC WPI JAPIO

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(54) Backlight for a liquid crystal display

(57) A plurality of light sources 31 emit violet light having a wavelength 380-420 nm which is capable of exciting the phosphors of a fluorescent layer 25 to illuminate a liquid crystal display 20, the light sources being energised consecutively, or scanned, at a sufficient rate to produce the appearance of a continuous image. As shown, the light sources may be cold cathode fluorescent tubes 31 stacked in parallel and having the same length as the LCD panel 20. Alternatively, the light sources may be GaN light emitting diodes. The fluorescent layer 25 includes phosphors emitting red, green, and blue light.

FIG. 2

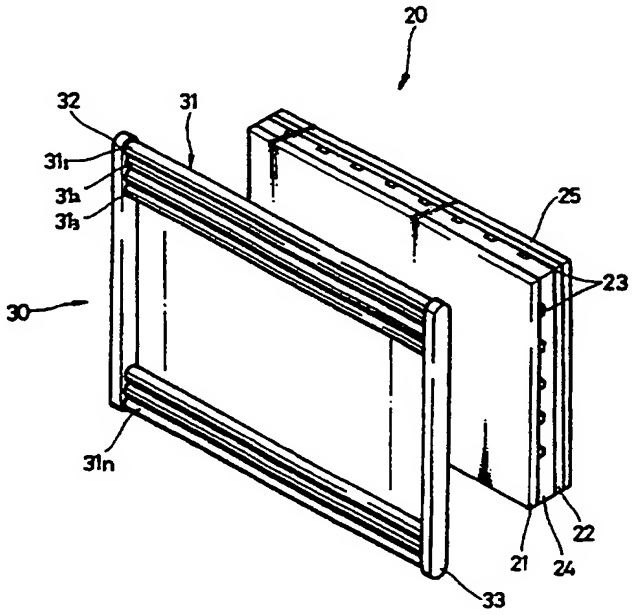

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FIG. 1

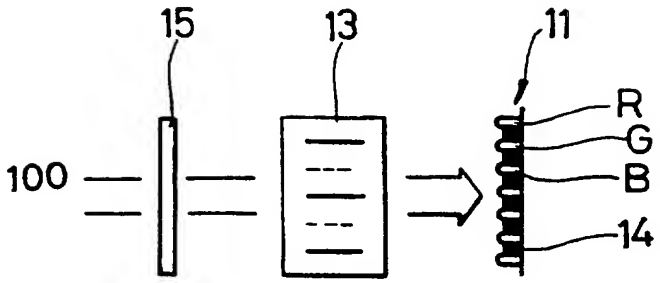


FIG. 2

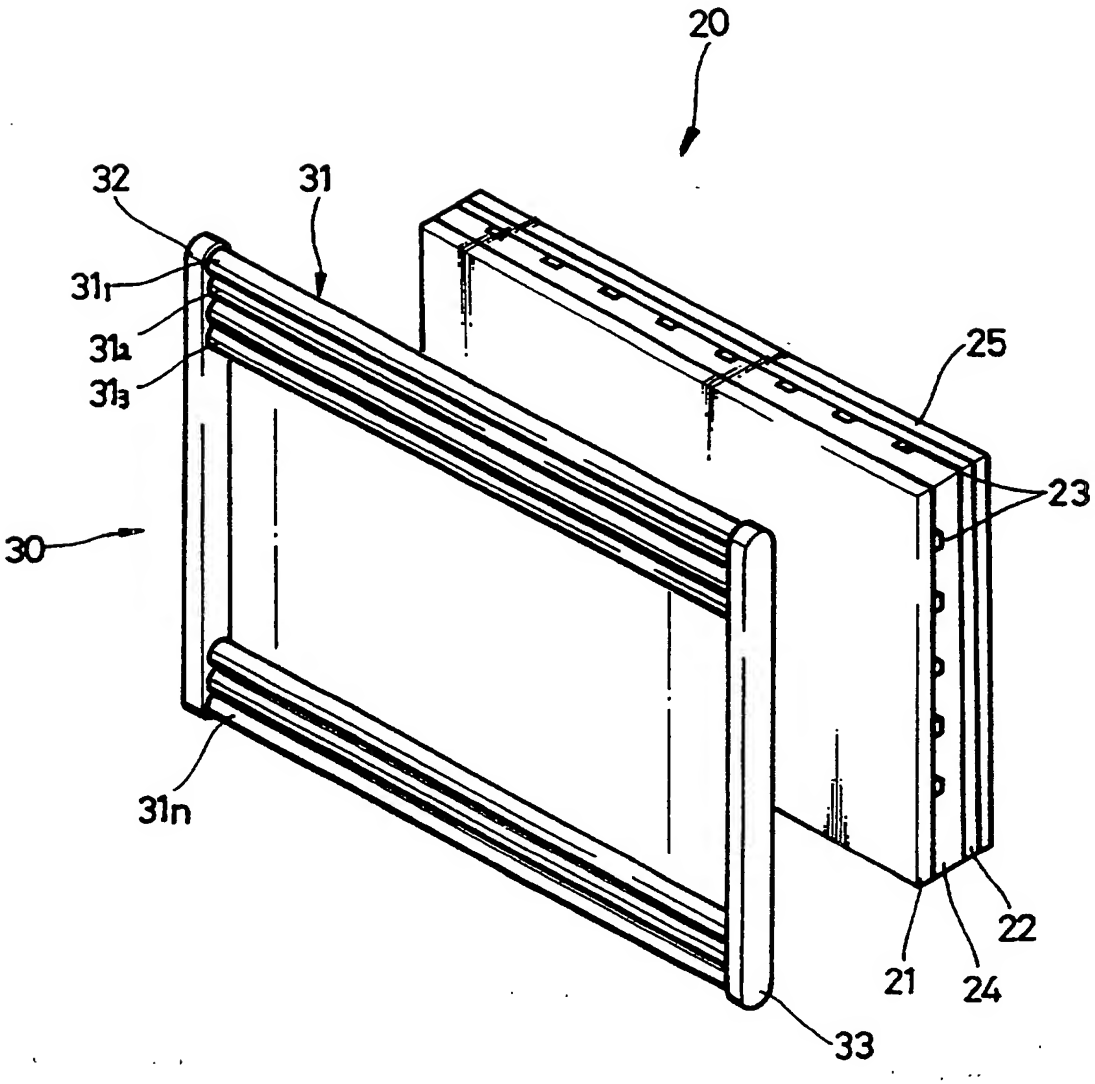
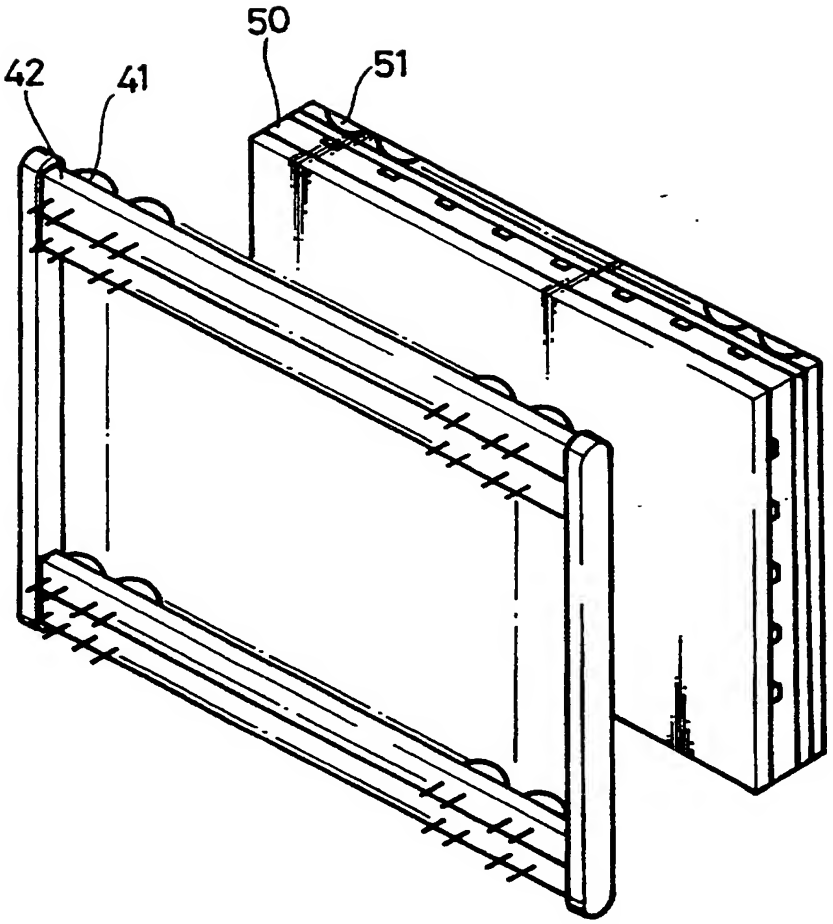


FIG. 3



CONSECUTIVE ILLUMINATING BACKLIGHT ASSEMBLY FOR LCD EMPLOYING FLUORESCENT LAYER

Background of the Invention

The present invention relates to a backlight assembly for a liquid crystal display (LCD), and more particularly, to a consecutive illuminating backlight assembly for an LCD employing a fluorescent layer.

Generally, an LCD is roughly divided into an LCD panel and a backlight assembly. Here, the LCD panel is interposed between two polarizing plates and includes two substrates, a liquid crystal layer interposed between two substrates and a color filter layer formed on one side of the substrate. The LCD is called a light receiving device as a color image is formed by filtering light emitted from the backlight assembly with the color filter. However, the color filter used for the image formation decreases amount of emitted light, lowering efficiency in use of light emitted from the backlight assembly.

To solve the above problem, an LCD having a fluorescent layer, as shown in FIG. 1, has been developed. As shown in FIG. 1, there is provided a fluorescent layer 11 on the front of a liquid crystal assembly 13, on which red (R), green (G) and blue (B) light emitting phosphors are coated. Also, a black matrix layer 14 made of graphite is formed between the phosphors.

In the LCD having the above structure, a light 100 emitted from a backlight source (not shown) passes through a transparent electrode 15 and then passes through the liquid

crystal assembly 13, depending on whether voltage is applied at that portion, to reach the fluorescent layer 11. The light arriving at the fluorescent layer 11 excites the designated phosphors to be illuminated. Since the above LCD realizes a color image by directly illuminating the phosphors, there is no need to interpose a color filter therein. As a result, the amount of light passing through the LCD increases, resulting in a sharper contrast.

However, in a conventional backlight assembly, a light transmitting plate (not shown) provided at the rear of the LCD panel distributes light emitted from the light source toward the LCD panel. However, it is impossible to provide equal illumination throughout the entire LCD panel using the light transmitting plate.

Furthermore, the conventional backlight assembly illuminates the entire rear side of the LCD panel, thereby wasting electrical energy.

Summary of the Invention

It is an object of the present invention to provide a backlight assembly for an LCD employing a fluorescent layer, for consecutively and repeatedly scanning to the rear side of an LCD panel, thereby creating a continuous screen using an afterimage effect of the eyes without wasting electrical power.

To achieve the above object, there is provided a consecutive illuminating backlight assembly for an LCD employing a fluorescent layer comprising: a plurality of cold

cathode fluorescent tubes stacked in parallel and having a length corresponding to the length of a LCD panel; and support plates for supporting the cold cathode fluorescent tubes and providing electrical connections to the cold cathode fluorescent tubes at both ends thereof, wherein the cold cathode fluorescent tubes are illuminated consecutively to form a continuous image on a screen, and emit violet rays having a wavelength of 380~420nm to excite phosphors of the fluorescent layer.

Here, it is preferable that the cold cathode fluorescent tube is incorporated with at least one element selected from the group consisting of Co, Ni and Fe, and comprises at least one phosphor selected from the group consisting of SrP_2O_7:Eu, $SrMgP_2O_7$:Eu, $Sr_3(PO_4)_2$:Eu, $(Sr,Ba)Al_2Si_2O_8$:Eu, $Y_2Si_2O_7$:Ce, $ZnGa_2O_4$:Li,Ti, $YTaO_4$:Nb, $CaWO_4$, $BaFX$:Eu (wherein X is halogen), $(Sr,Ca)O{\cdot}2B_2O_3$:Eu, $SrAl_{12}O_{14}$:Eu and Y_2SiO_5:Ce.

Also, there is provided a consecutive illuminating backlight assembly for an LCD employing a fluorescent layer comprising: a plurality of light emitting diodes as a light source; and a plurality of support plates stacked in parallel so that each support plate supports a line of the light emitting diodes, wherein the light emitting diodes are consecutively illuminated by lines to form a continuous image on a screen, and emits violet rays having a wavelength of 380nm to 420nm to excite phosphors of the fluorescent layer.

Preferably, the light emitting diode is formed of GaN-semiconductor, and the fluorescent layer consists of a blue light emitting phosphor, a green light emitting phosphor, and

a red light emitting phosphor, wherein the blue light emitting phosphor is at least one compound selected from the group consisting of $Sr_{10}(PO_4)_6Cl_{12}:Eu^{2+}$, $(Sr_{0.9}Ca_{0.1})_{10}(PO_4)_6Cl_2:Eu^{2+}$, $Sr_3MgSi_2O_8:Eu^{2+}$, $Ba_3MgSi_2O_8:Eu^{2+}$, ZnS:Ag,Cl, ZnS:Ag,Al, ZnS:Ag, ZnO:Ag and ZnS:Ag,Ga, the green light emitting phosphor is at least one compound selected from the group consisting of $SrAl_2O_4:Eu^{2+}$, $SrGa_2S_4:Eu^{2+}$, $Y_3Al_5O_{12}:Ce^{3+}$, ZnS:Cu, ZnS:Cu,Al, CdS:Cu,Al and ZnS:Cu,Au,Al, and the red light emitting phosphor is at least one compound selected from the group consisting of $6MgO\cdot As_2O_5:Mn$, $3.5MgO\cdot 0.5MgF_2\cdot GeO_2:Mn$, $SrY_2S_4:Eu$, $SrY_2S_4:Mn$, $K_5Eu(WO_4)_4$, $Y_2O_2S:Eu$ and $Y_2O_3:Eu$.

Brief Description of the Drawings

The above objects and advantages of the present invention will become more apparent by describing in detail preferred embodiments thereof with reference to the attached drawings in which:

FIG. 1 is a schematic structural diagram of a typical liquid crystal display (LCD) having a fluorescent layer for illustrating a backlight assembly;

FIG. 2 is a schematic perspective view of an LCD having a backlight assembly according to a preferred embodiment of the present invention; and

FIG. 3 is a schematic perspective view of the LCD having a backlight assembly according to another preferred embodiment of the present invention.

Detailed Description of the Invention

Referring to FIG. 2, a backlight assembly 30 of the present invention is provided at the rear of a liquid crystal display (LCD) panel 20. The LCD panel 20 includes a lower substrate 21, an upper substrate 22, a plurality of transparent electrodes 23 formed horizontally on top of the lower substrate 21 and vertically on the bottom of the upper substrate 22 so that the electrodes of the upper and lower substrates 21 and 22 cross each other, and a liquid crystal layer 24 between the lower and upper substrates 21 and 22. Also, rubbed alignment films (not shown) are formed on the surfaces of the lower and upper substrates 21 and 22 facing each other, and the liquid crystal molecules of the liquid crystal layer 24 are aligned along the rubbing direction of the alignment films.

In addition, lower and upper polarizing plates (not shown) are provided on each outer surface of the lower and upper substrates 21 and 22, and a fluorescent layer 25 coated with red (R), green (G) and blue (B) light emitting phosphors is provided on top of the upper polarizing plate.

The backlight assembly 30 according to the present invention includes a plurality of cold cathode fluorescent tubes 31 arranged at the rear of the LCD panel 20. The cold cathode fluorescent tubes 31 are stacked in parallel and has a length corresponding to the length of the LCD panel 20. The cold cathode fluorescent tubes 31 are supported by support plates 32 and 33 at the ends thereof and electrically connected to a power supply (not shown).

Ohta et al. (U.S. Patent No. 4,678,285) and Breddels et

al. (U.S. Patent No. 4,830,469) disclose a light source emitting ultraviolet rays or near-ultraviolet rays having a wavelength of 370nm or less to excite phosphors. However, the ultraviolet rays or the near-ultraviolet rays is easy to change the characteristics of liquid crystal molecules. Thus, the cold cathode fluorescent tubes 31 of the backlight assembly 30 according to the present invention adopts a light source emitting violet rays having a wavelength range of 380 to 420nm, which is disclosed by the present inventors (U.S. Patent Application No. 08/385,514). That is, the light source includes one phosphor selected from the group consisting of SrP_2O_7:Eu, $SrMgP_2O_7$:Eu, $Sr_3(PO_4)_2$:Eu, $(Sr,Ba)Al_2Si_2O_8$:Eu, $Y_2Si_2O_7$:Ce, $ZnGa_2O_4$:Li,Ti, $YTaO_4$:Nb, $CaWO_4$, BaF*X*:Eu (wherein *X* is halogen), $(Sr,Ca)O{\cdot}2B_2O_3$:Eu, $SrAl_{12}O_{14}$:Eu and Y_2SiO_5:Ce. The violet rays emitted from the light source effectively illuminate the phosphors of the fluorescent layer 25 without changing the characteristics of the liquid crystal molecules.

Preferably, the phosphors disclosed in the above U.S. Patents and U.S. Patent Application No. 08,385,514 are used as the phosphors of the fluorescent layer 25. That is, the fluorescent layer consists of a blue light emitting phosphor, a green light emitting phosphor, and a red light emitting phosphor, wherein the blue light emitting phosphor is at least one compound selected from the group consisting of $Sr_{10}(PO_4)_6Cl_{12}$:Eu^{2+}, $(Sr_{0.9}Ca_{0.1})_{10}(PO_4)_6Cl_2$:$Eu^{2+}$, $Sr_3MgSi_2O_8$:Eu^{2+}, $Ba_3MgSi_2O_8$:Eu^{2+}, ZnS:Ag,Cl, ZnS:Ag,Al, ZnS:Ag, ZnO:Ag and ZnS:Ag,Ga, the green light emitting phosphor is at least one compound selected from the group consisting of $SrAl_2O_4$:Eu^{2+},

$SrGa_2S_4:Eu^{2+}$, $Y_3Al_5O_{12}:Ce^{3+}$, ZnS:Cu, ZnS:Cu,Al, CdS:Cu,Al and ZnS:Cu,Au,Al, and the red light emitting phosphor is at least one compound selected from the group consisting of $6MgO \cdot As_2O_5:Mn$, $3.5MgO \cdot 0.5MgF_2 \cdot GeO_2:Mn$, $SrY_2S_4:Eu$, $SrY_2S_4:Mn$, $K_5Eu(WO_4)_4$, $Y_2O_2S:Eu$ and $Y_2O_3:Eu$.

Also, in order to prevent light of wavelengths above 420nm from being illuminated, the cold cathode fluorescent tubes 31 are coated with a film of at least one selected from the group consisting of cobalt (Co), nickel (Ni) and iron (Fe).

According to the backlight assembly of the present invention, the cold cathode fluorescent tubes 31 may be illuminated consecutively in the same way that television screens are scanned. That is, the uppermost fluorescent tube 31_1 is illuminated, then, after a predetermined time, the uppermost fluorescent tube 31_1 is turned off. As the uppermost fluorescent tube 31_1 is turned off, the next fluorescent tube 31_2 is illuminated. (Here, even though the fluorescent tube 31_1 is turned off, a diminishing illumination still glows.) Then, as the fluorescent tube 31_2 is turned off, a fluorescent tube 31_3 under the fluorescent tube 31_2 is illuminated. This is repeated for all the fluorescent tubes to a fluorescent tube 31_n. In this manner, all of the cold cathode fluorescent tubes 31 are illuminated. Here, preferably, an illuminating period of each of the fluorescent tubes 31 is controlled so that a viewer perceives the consecutively illuminated image as a continuous image due to the afterimage effect of the eyes. Thus, the consecutive line illumination of the cold cathode

fluorescent tubes 31 has the same effect as a surface illumination of the entire fluorescent layer 25.

The light illuminated from the consecutive illuminating backlight assembly is polarized by the lower polarizing plate (not shown) and then passes through the lower substrate 21 to reach the liquid crystal layer 24. When a voltage is applied to the transparent electrodes 23 from a power source which is independent of the power source of the backlight assembly, the liquid crystal molecules which are usually arranged in spiral form line up with respect to the transparent electrodes 23. Thus, light passes through the liquid crystal layer 24, the upper substrate 22 and the upper polarizing plate (not shown) in sequence and then reaches the fluorescent layer 25. The light arriving at the fluorescent layer 25 excites the designated phosphors of the fluorescent layer 25 to be illuminated, thereby providing a color image.

FIG. 3 shows the consecutive illuminating backlight assembly according to another preferred embodiment of the present invention. As shown in FIG. 3, a plurality of support plates 42 are stacked in parallel and each support plate is provided with a plurality of light emitting diodes 41. The light emitting diodes 41 are made of GaN-semiconductor to easily control the wavelength of the light emitted therefrom.

The plurality of light emitting diodes 41 are arranged in lines and each line of light emitting diodes 41 is supported by one of the support plates 42. The light emitting diodes 41 of one line are simultaneously illuminated or turned off and the light emitting diodes 41 are consecutively illuminated or

turned off by line, thereby creating a continuous image. The violet rays emitted from the light emitting diodes 41 pass through a LCD panel 50 to excite phosphors 51 of a fluorescent layer.

The consecutive line illumination of the present invention provides uniform illumination of light over the LCD panel as well as a surface illuminating effect of the entire fluorescent layer, thereby lowering power consumption.

What is claimed is:

1. A consecutive illuminating backlight assembly for a liquid crystal display (LCD) employing a fluorescent layer comprising:

a plurality of cold cathode fluorescent tubes stacked in parallel and having a length corresponding to the length of a LCD panel; and

support plates for supporting said cold cathode fluorescent tubes at both ends thereof and providing electrical connections to said cold cathode fluorescent tubes at both ends thereof,

wherein said cold cathode fluorescent tubes are illuminated consecutively to form a continuous image on a screen, and emit violet rays having a wavelength of 380~420nm to excite phosphors of said fluorescent layer.

2. A consecutive illuminating backlight assembly as claimed in claim 1, wherein said fluorescent layer consists of a blue light emitting phosphor, a green light emitting phosphor, and a red light emitting phosphor,

wherein said blue light emitting phosphor is at least one compound selected from the group consisting of $Sr_{10}(PO_4)_6Cl_{12}:Eu^{2+}$, $(Sr_{0.9}Ca_{0.1})_{10}(PO_4)_6Cl_2:Eu^{2+}$, $Sr_3MgSi_2O_8:Eu^{2+}$, $Ba_3MgSi_2O_8:Eu^{2+}$, ZnS:Ag,Cl, ZnS:Ag,Al, ZnS:Ag, ZnO:Ag and ZnS:Ag,Ga, said green light emitting phosphor is at least one compound selected from the group consisting of $SrAl_2O_4:Eu^{2+}$, $SrGa_2S_4:Eu^{2+}$, $Y_3Al_5O_{12}:Ce^{3+}$, ZnS:Cu, ZnS:Cu,Al, CdS:Cu,Al and ZnS:Cu,Au,Al, and said red light emitting phosphor is at least one compound selected from the group consisting of

$6MgO \cdot As_2O_5:Mn$, $3.5MgO \cdot 0.5MgF_2 \cdot GeO_2:Mn$, $SrY_2S_4:Eu$, $SrY_2S_4:Mn$, $K_5Eu(WO_4)_4$, $Y_2O_2S:Eu$ and $Y_2O_3:Eu$.

3. A consecutive illuminating backlight assembly as claimed in claim 1, wherein said cold cathode fluorescent tube comprises at least one phosphor selected from the group consisting of $SrP_2O_7:Eu$, $SrMgP_2O_7:Eu$, $Sr_3(PO_4)_2:Eu$, $(Sr,Ba)Al_2Si_2O_8:Eu$, $Y_2Si_2O_7:Ce$, $ZnGa_2O_4:Li,Ti$, $YTaO_4:Nb$, $CaWO_4$, $BaFX:Eu$ (wherein X is halogen), $(Sr,Ca)O \cdot 2B_2O_3:Eu$, $SrAl_{12}O_{14}:Eu$ and $Y_2SiO_5:Ce$.

4. A consecutive illuminating backlight assembly as claimed in claim 3, wherein said cold cathode fluorescent tube is coated with at least one element selected from the group consisting of Co, Ni and Fe.

5. A consecutive illuminating backlight assembly for an LCD employing a fluorescent layer comprising:

a plurality of light emitting diodes as a light source; and

a plurality of support plates stacked in parallel so that each support plate supports a line of said light emitting diodes,

wherein said light emitting diodes are consecutively illuminated by lines to form a continuous image on a screen, and emits violet rays having a wavelength of 380nm to 420nm to excite phosphors of said fluorescent layer.

6. A consecutive illuminating backlight assembly as claimed in claim 5, wherein said fluorescent layer consists of a blue light emitting phosphor, a green light emitting phosphor, and a red light emitting phosphor,

wherein said blue light emitting phosphor is at least one compound selected from the group consisting of $Sr_{10}(PO_4)_6Cl_{12}:Eu^{2+}$, $(Sr_{0.9}Ca_{0.1})_{10}(PO_4)_6Cl_2:Eu^{2+}$, $Sr_3MgSi_2O_8:Eu^{2+}$, $Ba_3MgSi_2O_8:Eu^{2+}$, ZnS:Ag,Cl, ZnS:Ag,Al, ZnS:Ag, ZnO:Ag and ZnS:Ag,Ga, said green light emitting phosphor is at least one compound selected from the group consisting of $SrAl_2O_4:Eu^{2+}$, $SrGa_2S_4:Eu^{2+}$, $Y_3Al_5O_{12}:Ce^{3+}$, ZnS:Cu, ZnS:Cu,Al, CdS:Cu,Al and ZnS:Cu,Au,Al, and said red light emitting phosphor is at least one compound selected from the group consisting of $6MgO{\cdot}As_2O_5:Mn$, $3.5MgO{\cdot}0.5MgF_2{\cdot}GeO_2:Mn$, $SrY_2S_4:Eu$, $SrY_2S_4:Mn$, $K_5Eu(WO_4)_4$, $Y_2O_2S:Eu$ and $Y_2O_3:Eu$.

7. A consecutive illuminating backlight assembly as claimed in claim 5, wherein said light emitting diode is formed of GaN-semiconductor.

8. A consecutive illuminating backlight assembly as claimed in claim 1 substantially as herein described with reference to the accompanying drawings.

The Patent Office

Application No:	GB 9705790.5	**Examiner:**	Mr.G.M Pitchman
Claims searched:	1 to 8	**Date of search:**	6 June 1997

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.O): G5C (CHX)

Int Cl (Ed.6): G02F 1/1335 G09G3/34

Other: ONLINE: EDOC WPI JAPIO

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
Y	GB 2291734 A	(SAMSUNG)-see whole document	1-4
Y	WO 94/09474 A1	(PANOCORP)-see abstract and page 25 line 8 to page 26 line 13	1-4

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X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.